

Biomass Processing and Bio-energy

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Abstract: Biofuels are type of sustainable energy produced from organic waste that play an useful role in reduction of emissions of CO₂. The production of biodiesel fuel from renewable resource is a sustainable substitute for petroleum based fuels as economic and environmental sustainability. Algae is one of the most important source of biomass as it absorbs a large amount of carbon from the atmosphere and industries, and uses nutrients extracted from the industrial and municipal wastewater. Microalgae are more efficient and can produce about 10 times more amount of oil as compared to the plants which are rich in oil and they can be grown in open ponds or photo bioreactors. Algae-based biofuel has a great potential in revolutionizing the energy industry and fight against the greenhouse gas emissions

Keywords: Biodiesel, Renewable resource, Sustainability, Microalgae, Biofuel, Greenhouse gas

1. INTRODUCTION:

The increasing demand of energy and greenhouse gas emissions has been a major concern for all since last decades. Fossil fuel have limitations for their contribution in the atmosphere[1]. Biofuels are the alternative sources to fossil fuels and greenhouse gas emissions such as carbon dioxide, methane, etc. as they are more ecologically acceptable energy source as compared to the fossil fuel [2].

Biofuels are divided into primary and secondary biofuels. Primary biofuels such as fuel wood are used in unprocessed forms, i.e. for heating, cooking or producing electricity, whereas secondary biofuels such as bioethanol and biodiesel are produced by processing biomass and are used in vehicles and for various industrial processes[3]. The secondary biomass are classified into three generations – first, second and third generation biofuels based on different parameters (figure 1).

The first generation biofuel system consists of economic and environmental limitations. The major concern for biofuels is that as the capacity of production increases, their competition with the agriculture for production of food on land also increases[4].

The second generation biofuel system consists of the production of fuels from lignocellulosic biomass that is the woody part of the plant which do not competes with the production of food. The sources of second generation biofuel system includes – agricultural residues, forest residues and wood processing wastes such as straw, leaves, etc. along with the non-edible part of corn or sugarcane.

The third generation biofuels are produced from microalgae which are the sources for alternative energy resource associated with the first and second generation biofuel systems[4]–[6].

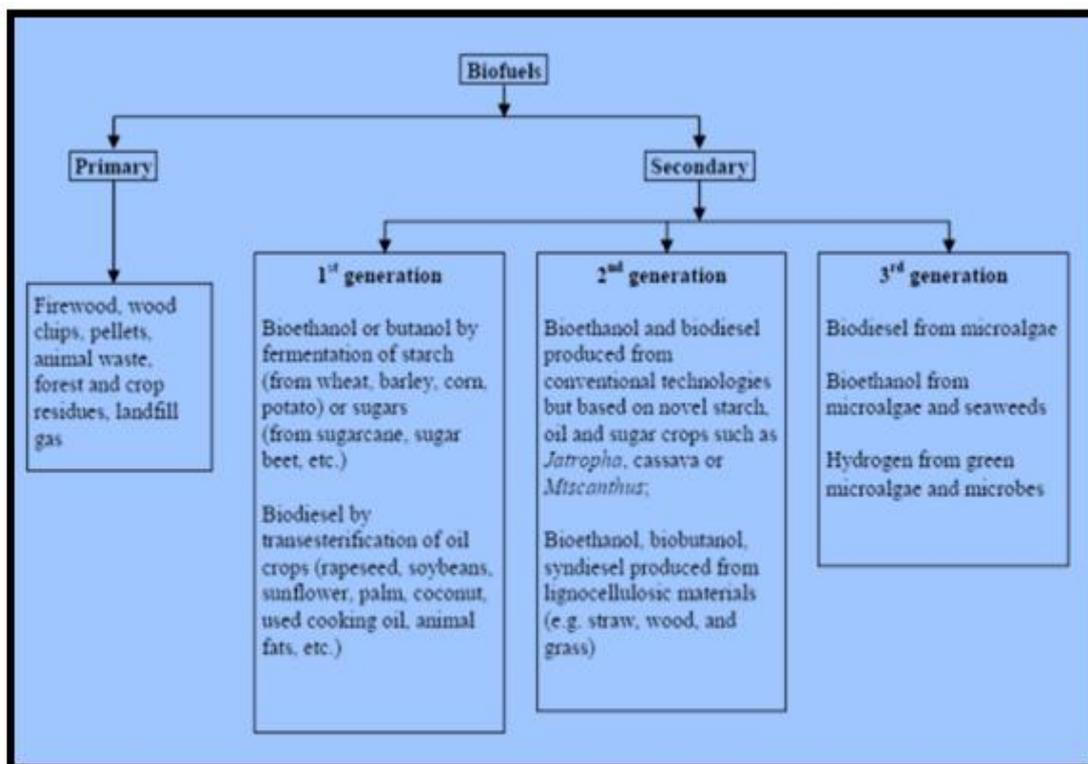


Fig. 1: Classification of Biofuels

1. Algal Oil:

Algae (microalgae) contain 3 basic components which include:

- i) Protein
- ii) Carbohydrate
- iii) Lipids and fatty acids

Lipids and fatty acids are present in microalgae as

- i) storage product,
- ii) membrane component,
- iii) metabolites and
- iv) energy sources.

They are mainly extracted from microalgae as algal oil. Algal oil consists of two basic components;

- i) Saturated fatty acids
- ii) Monounsaturated fatty acids

“Saturated fatty acids” are organic acids with straight chain that are good source of diet. They can be short chain, mid chain and long chain with carbon number ranging from 4-12, 13-16 and 17-26 respectively[7].

“Unsaturated fatty acids” are biosynthesized by a unique reaction of dehydrogenation known as desaturation. They are identified by the presence of a single double bond or more than double bond in the fatty acids[8].

Composition of unsaturated and saturated fatty acids present in the algal oil is (i) Oleic (18:1) – 36% (ii) Palmitic (16:0) – 15% (iii) Stearic (18:0) – 11% (iv) Linoleic (18:2) – 8.4% (v) Linolenic (18:3) – 7.4%[9]–[12].

There are various applications of algal oil, from which two main applications are:

- i) Biodiesel production which has the potential to be served as renewable source of energy, substitution of diesel produced from fossil fuels.

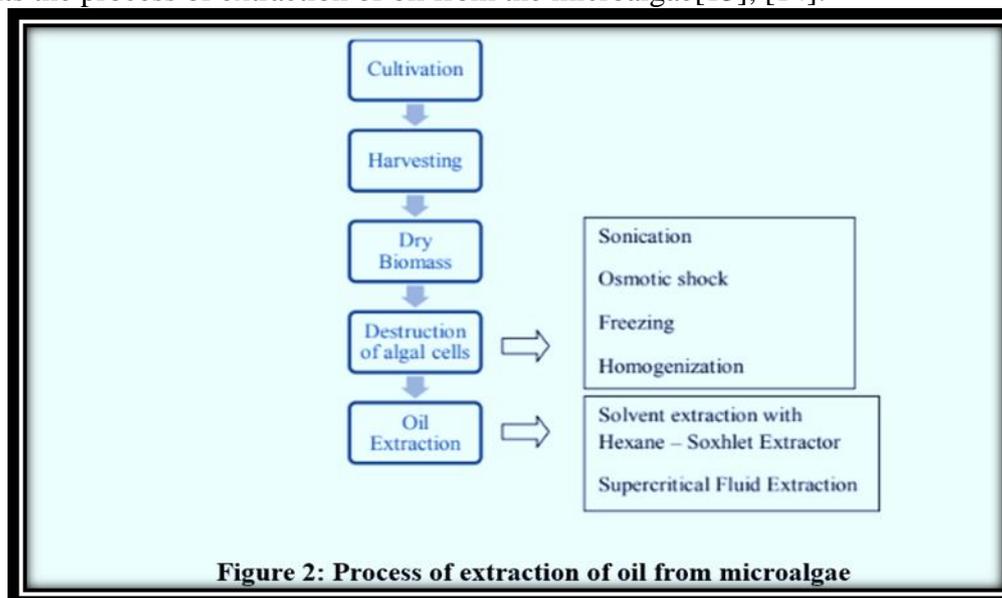
ii) They are also beneficial in human nutrition in the form of omega 3 fatty acids. Table 1 presents the oil content percentage in micro-algae species.

TABLE 1: Micro-algae species with their oil content

Microalgae Species	Oil content (% dry weight)
<i>Chlorella vulgaris</i>	25-35
<i>Botryococcus braunii</i>	30-80
<i>Schizochytrium sp.</i>	55-75
<i>Nannochloropsis sp.</i>	30-70
<i>Neochloris sp.</i>	35-65
<i>Nitzschia sp.</i>	45-50
<i>Dunaliella primolecta</i>	20-30

2. Oil Extraction from Microalgae Process:

The process involves, collection and cultivation of various microalgae which is then harvested to obtain ample amount of biomass in order to produce biofuel. After harvesting the biomass is collected to obtain a dry biomass. The collected cells of the algal biomass is further destructed by undergoing various process which include sonication, osmotic shock followed by freezing and homogenizing the cells to obtain cells of different size i.e. destructed algal cells. Finally the oil is extracted from the homogenized algal cells. Figure 2 represents the process of extraction of oil from the microalgae[13], [14].



3. Advantages of Algal Biomass:

The biofuel produced from the algal biomass has several advantages, few of them are cited herein as:

a) Biofuel produced from the algal biomass are the potent source of renewable energy. Microalgae are among the most efficient forms of output of sustainable energy. It can expand at high levels and produce oil throughout the year.

b) Emit less particulate pollution. Since biofuels are generated from sustainable energy sources, they create fewer side effects to the earth. When burned, they emit lower CO₂ levels and other harmful emissions.

c) They are cheaper than fossil fuels. Biofuels are very much safer than fossil fuel from an environmental point of view since it produces low air pollution and consumes waste materials for their production. They are much cheaper than fossil fuel and will definitely be cheaper in upcoming years.

d) They have lead to reduction in wastes. Using surplus biomass to produce energy will mitigate issues with waste management, deforestation, greenhouse gas, as well as fossil fuels utilization. This can ultimately leads to lessen the harmful effects of the global warming.

e) Biofuel production from microalgae is nutritious to humans as well as reduces diseases caused to human health due to pollution.

2. CONCLUSION

Microalgae are among the most productive sources of output of sustainable energy. Microalgae are likely to be important raw material with useful by-products for amino acids and vitamins. Microalgae production is recognized to be the most profitable business in the biotechnology process. It causes less waste and environmentally safe. Microalage have the potential for the production of biodiesel that replaces the petroleum-based fuel. The biodiesel fuel production using the algae leads to production of high yield of oil. However, the algal biofuels still requires to be studied more for various applications.

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